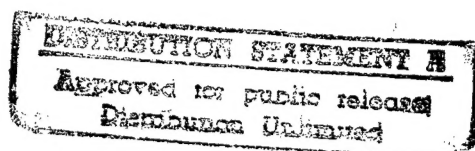


JPRS-UES-90-007  
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# ***JPRS Report***



# **Science & Technology**

***Science & Technology  
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# Science & Technology

## USSR: Earth Sciences

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UDC 550:831

### **Deep Structure and Gravity Field of Kuril Arc-Trench System**

907N0144A Novosibirsk TIKHOOKEANSKAYA  
GEOLOGIYA in Russian No 2, Mar-Apr 90  
(manuscript received 12 Sep 88) pp 16-22

[Article by A. A. Andreyev and T. K. Zlobin, Institute of Marine Geology and Geophysics, Far Eastern Department, USSR Academy of Sciences, Yuzhno-Sakhalinsk]

[Abstract] In the Greater Kuril Arc the crust has a thickness of about 30 km; it is characterized by a layered-block structure and increased mean velocities of seismic waves (and density). New and earlier data obtained by deep seismic sounding and other methods were used in constructing a revised generalized seismic section of the crust along the entire Kuril Arc and a density section of the crust. The "mantle anomaly" across the arc section through Simushir Island was computed. Modern data on the seismic section of the crust have introduced a substantially new contribution to understanding of the nature of mechanical equilibrium in the arc-trench system. The Greater Kuril Arc is close to isostatic compensation in the Bullard (Airy-Pratt) model due to the clearly expressed division of the crust into blocks beneath which there is a mantle with reduced viscosity (density), which favors this compensation. The abyssal trench is a structure which is isostatically sharply uncompensated at a depth of 40 km. At greater depths this lack of compensation is probably not so sharply expressed due to the presence of positive "excess" masses beneath the trench. This review of the presented materials gives basis for postulating a reduced density of the upper mantle in the middle part of the island arc relative to upper mantle density beneath its flanks. Figures 4; references 17: 11 Russian, 6 Western.

UDC 549.35 + 553.44.1571.62

### **Localization Factors for Gold-Silver Mineralization in Calcareous Covering Strata of Okhotsk Median Mass**

907N0144B Novosibirsk TIKHOOKEANSKAYA  
GEOLOGIYA in Russian No 2, Mar-Apr 90  
(manuscript received 28 Oct 88) pp 43-46

[Article by V. L. Kelmachev and M. I. Oparin, Far Eastern Institute of Raw Materials, Khabarovsk]

[Abstract] Gold and silver mineralization has been discovered for the first time in the calcareous rock cover of the Okhotsk median mass. Information is given on the geological factors governing the localization and patterns

of distribution of this mineralization. These factors are compared with those governing classical near-surface shows. The pertinent lithological-stratigraphic, magmatic and metamorphic factors are discussed. On the basis of a comparison of geological factors governing the localization of near-surface gold-silver mineralization in the Okhotsk-Chukotka volcanogenic zone and gold-silver mineralization in the calcareous rocks in the cover of the Okhotsk median mass it is postulated that both types of mineralization are a result of the same processes and some special features of their mineralogy and morphology are a result of differences in the physicochemical characteristics of the ambient medium and variations in the depth and temperature of their formation. Taking into account the extensive area of development of these calcareous rocks within the limits of the Okhotsk median mass the analyzed materials suggest the possibility that gold and silver mineralization in the region may be more widespread than believed earlier. These materials can also be used in evaluating the possibilities for such mineralization in contiguous territories of the North-eastern USSR and Yakut ASSR with a similar geological structure. Figure 1; references: 2 Russian.

UDC 552.32(571.645)

### **Amphiboles in Intrusive Rocks of Kunashir Island (Kuril Island Arc)**

907N0144C Novosibirsk TIKHOOKEANSKAYA  
GEOLOGIYA in Russian No 2, Mar-Apr 90  
(manuscript received 1 Apr 88) pp 108-111

[Article by A. V. Rybin, Institute of Marine Geology and Geophysics, Far Eastern Department, USSR Academy of Sciences, Yuzhno-Sakhalinsk]

[Abstract] The composition of amphiboles from the acidic intrusive rocks of Kunashir Island was studied. The research revealed the presence of two types of amphiboles in the intrusive rocks of the southern part of the Kuril arc which differ in their optical and chemical properties. The first of these is primary magmatic and characterizes the conditions for formation of the initial phases of quartz-diorites and granodiorites. The second type of amphiboles has an intermediate composition between hornblende and actinolite and was probably formed during interaction of quartz-diorites with later silicate melts. Amphiboles from plagiogranites are characterized by chemical properties close to actinolite and were probably formed under conditions of autometasomatism in the late magmatic stage. An analysis of the depth of formation of intrusive bodies, determined from the composition of the amphiboles, indicates that the crystallization of the mineral paragenesis plagioclase + hornblende in the initial phases of the melts occurs at a pressure 1-2.5 kbar. Figures 2; references 11: 8 Russian, 3 Western.

**Oceanographic Research**

18650227 USA USSR TECHNOLOGY UPDATE  
in English 3 May 90 pp 1, 8

[Text] The USSR Academy of Sciences' Acoustic Institute has been given a new vessel, the "Akademic Boris Konstantinov," equipped with a thruster, modern navigational equipment, satellite-aided communications, computers, and unique apparatus for acoustic-method study of ocean water. It was built at the Okean shipyard in Nikolayev. After a trial cruise from the Black Sea to the Baltic Sea, it is now set out for the Pacific Ocean for protracted field tests before returning to Leningrad in spring 1990.

The research ship "Professor Kolesnikov" of the Marine Hydrophysics Institute, Ukrainian Academy of Sciences, Sevastopol, was used in joint aircraft-ship research on evolution of wind waves on non-uniform currents. An aircraft photographed the sea at intersection points of a 10-mile-interval grid in an 80-square-mile test range in the western Black Sea for several hours, to determine spatial variability of parameters of wind waves on non-uniform currents under conditions of a quasiuniform wind field. A calibration curve was constructed from the joint results, and radar backscattering section measurements gave estimates of mean velocity of the near-water wind and its degree of uniformity in the area. It was found that influence of currents can be discriminated when there are quasihomogeneous wave-generating factors in the fields of integral characteristics of the two-dimensional spectrum of wind waves. Spatial variability of these fields with respect to structural characteristics does not contradict refraction equations for waves on currents.

The "Akademik Keldysh" measured fluctuation parameters of radar signal scattered by sea surface for the USSR Academy of Sciences' Space Research Institute and Oceanology Institute in summer 1983. Using the "Okean" shipboard radar, a modified modulation function, determined by the ratio of the power spectra of the scattered signals. Long-wave effects are caused by purely hydrodynamic effects due to influence exerted on ripples by the orbital velocity of long waves and different wave-generation conditions along a long wave, and also due to changes in the local angle of radar on different parts of the wave in the vertical plane. Signal variability from these factors increases as glancing angle decreases, and has a distinct anisotropy in the horizontal plane caused by the narrow angular spectrum of long waves. Wind is a destabilizing factor, reducing the modulation effect.

The research vessels "Akademik Vernatskiy" and "Mikhail Lomonosov" studied temperature oscillations in ocean and atmosphere in the western Middle Atlantic covering the Amazon bay, Guyana shelf and Caribbean basin. Readings were taken in sufficiently short time intervals and over a sufficiently long period for reliable statistics and spectrum analysis by the maximum entropy method.

**Gravity Field of the Oceans Based on Satellite Altimetry Data**

907N0136A Moscow VESTNIK MOSKOVSKOGO  
UNIVERSITETA: GEOLOGIYA in Russian No 2,  
Mar-Apr 90 (manuscript received 10 Mar 89) pp 69-73

[Article by A. G. Gaynanov, T. P. Zakharova, Ye. L. Mazo and D. A. Kholodnykh, Moscow University]

[Abstract] This comparative analysis of marine gravity chart and satellite altimetry data of the Atlantic Ocean confirms the findings of an earlier U.S. study by R. H. Rapp, reported in the Journal of Geophysical Research, Vol. 91, 1986, that the accuracy of satellite altimetry derived gravity values approximates that of marine gravimetric measurements. The gravimetric charts used in this study are of Soviet origin, having been compiled by the Department of Geophysical Methods of Investigation of the Earth's Crust, Moscow University. Based on gravity anomaly values averaged over one-degree grid squares, the charts have rms errors of free-air gravity anomalies ranging from  $\pm 4$  to  $\pm 25$  mGal. On average, in the North and Central Atlantic, the mean anomaly error is  $\pm 7-8$  mGal, in the South Atlantic,  $\pm 13-15$  mGal. The satellite altimetry data are mostly of U.S. origin, having been collected by Geos-3 and Seasat. Comparable gravity field and satellite altimetric values were reduced to a single gravity data system. For well-studied sheets of the Mid-Atlantic Ridge, the rms deviation between marine gravimetric and satellite altimetric data was 5-6 mGal. for latitudinal profiles in the North Atlantic, the rms deviation was 6-9 mGal. Histograms of divergence values between gravimetric and altimetric data show an almost normal deviation distribution. The accuracy of altimetric values was constant over all the oceans, with the rms deviation from marine gravimetric data not exceeding  $\pm 5-9$  mGal. Particular reference is made to earlier studies of this problem by M. Ye. Artemyev. Figure 1; references 17: 6 Russian, 11 Western.

UDC 551.465.5

**Estimation of Penetration Depth and Lifetime of Gas Bubbles Produced by Breaking Wind Waves**

907N0148A Moscow OKEANOLOGIYA in Russian  
Vol 30 No 3, May-Jun 90 (manuscript received 7 Dec 88, after revision 2 Jul 89) pp 393-399

[Article by V. K. Goncharov and N. Yu. Klementyeva]

[Abstract] The process of saturation of the sea surface layer with bubbles was reexamined. A decrease in the intensity of gas transfer through a bubble boundary, associated with sorption on its surface of the surfactants present in sea water, causes an increase in the lifetime of bubbles, which in turn makes possible the entrainment of bubbles forming during the breaking of wind waves into great depths by descending flows, which are strongest in regions of convergence of Langmuir circulation cells reaching the upper boundary of the seasonal thermocline. Systems of equations are derived for describing



movement in descending flows and the dissolving of bubbles containing air trapped from the atmosphere, which is regarded as a single-component ideal gas and as a mixture of nitrogen and oxygen. Numerical modeling made it possible to analyze the process of saturation of the sea surface layer with bubbles and to evaluate the effects associated with the representation of the gas present in a bubble in the form of a single-component gas (air) or mixture of gases (nitrogen and oxygen) and with variation of the coefficient of gas diffusion through the boundary of the bubble. Figures 2; references 12: 9 Russian, 3 Western.

UDC 551.464.5

#### **Determining Salinity of Thin Surface Microlayer of Sea Water**

907N0148B Moscow OKEANOLOGIYA in Russian  
Vol 30 No 3, May-Jun 90 (manuscript received 6 Feb 89)  
pp 400-405

[Article by V. S. Savenko, Moscow State University imeni M. V. Lomonosov]

[Abstract] Available data on salinity of the surface microlayer (SML) of different oceans and seas are summarized in a table, indicating that usually the salinity of the SML is 1-2% greater than the salinity of subsurface waters, falling in the range from 0.8 to 4.2%. However, there are still serious difficulties in determining salinity in the SML, first because such measurements are usually made electrometrically on the assumption of a constancy of the salt composition of sea water, which has been demonstrated only for subsurface waters, and second, because in the process of sampling of the SML there may be a substantial change in salinity as a result of evaporation of water from the sampler surface during the time expended in transferring the samples into a container, an effect which has never been quantitatively estimated and which casts doubt on available data on salinity in the SML. A new method is described for accurately determining real salinity which involves use of a series of samples with different times of exposure of the samplers in the air. The method is illustrated in the example of the Black Sea where the differences in SML salinity are 0.7-1.2% under calm conditions and which become negligible with an increase in wind speed above 8 m/s. Thus, in actuality, changes in the main salt composition of the SML are small and salinity can be determined using an electrosalinometer. Figure 1; references 15: 14 Russian, 1 Western.

UDC 551.462

#### **Reference Samples of Ferromanganese Nodules and Ambient Sediments**

907N0148C Moscow OKEANOLOGIYA in Russian  
Vol 30 No 3, May-Jun 90 (manuscript received 11 Sep 89)  
pp 455-463

[Article by L. A. Berkovits, V. G. Obolyaninova and G. N. Baturin, Oceanology Institute imeni P. P. Shirshov, USSR Academy of Sciences, Moscow]

[Abstract] The first series of reference samples of the composition of ore formations and pelagic sediments in the ocean has been prepared for ferromanganese nodules (SDO-4, SDO-5, SDO-6), ore encrustations (SDO-7), diatomaceous ooze (SDO-8) and red abyssal clay (SDO-9). The samples are intended for metrological support of physical, physicochemical and chemical methods for the analysis of ferromanganese ore materials and oceanic sediments. The samples were tested for rock-forming components and a number of trace elements (each sample for the content of 26-33 elements, but for the time being not for gold, silver, rare earths, and some others). The tested characteristics were computed on the basis of the statistical processing of data obtained in an interlaboratory experiment (as many as 77 laboratories participated) for the analysis of samples by different (gravimetric, photometric, titrimetric, flame photometry, atomic absorption) methods. References 13: 7 Russian, 6 Western.

UDC 551.462

#### **Quantitative Characterization of Ferromanganese Nodules Form Parameters**

907N0148D Moscow OKEANOLOGIYA in Russian  
Vol 30 No 3, May-Jun 90 (manuscript received 11 Apr 89)  
pp 464-468

[Article by P. G. Dietrich, Freiberg Mining Academy, German Democratic Republic]

[Abstract] Numerous classifications have been proposed for Fe-Mn nodules based on their form, surface characteristics and morphogenetic types. With these taken into account, the possibility is explored for using traditional statistical methods employed in sedimentation analysis for a quantitative description of the fields of development of Fe-Mn nodules on the basis of size of ore bodies, their form and surface properties. It was found that the sizes of ore bodies and their form parameters, characterized by the ratio of axes, are related to the local morphology of the ocean floor and to the chemical composition of Fe-Mn nodules. In particular, the sizes of the bodies and the ratio of height to width correlate with the content of Mg, Al and Mn. Objective, reproducible and statistically significant data can therefore be obtained on the form and size of Fe-Mn nodules. Such data can be used in addition to classification schemes and regional comparisons and correlations with the chemical and mineralogical parameters of Fe-Mn nodules and substrates can be put on a quantitative comparison basis. Figures 4; references 12: 3 Russian, 9 Western.

UDC 551.462.62

#### **Detailed Hydromagnetic Survey of Mid-Atlantic Ridge Between 23 and 26° N**

907N0148E Moscow OKEANOLOGIYA in Russian  
Vol 30 No 3, May-Jun 90 (manuscript received 14 Mar 89)  
pp 469-478

[Article by S. V. Aplonov, N. Yu. Bocharova and E. A. Popov, Leningrad Division, Oceanology Institute imeni P. P. Shirshov]

[Abstract] A detailed hydromagnetic survey was made of the axial zone of the Mid-Atlantic Ridge between 23 and 26°N during the 15th cruise of the "Akademik Mstislav Keldysh" in March-May 1988. The survey was carried out in two test ranges with an average distance between runs of 1 km and along several regional runs. The results of two-dimensional simulation of the magnetically active layer revealed a sharp increase in the rate of spreading 730 000 years ago from 2.2 to 3.2 cm/year. An asymmetry of opening of opposite direction was discovered: eastern—to the north and western—to the south of the Kane fracture zone; this is compensated at approximately 24°30'N, 90-100 km to the north of the Kane fracture zone. During the last 730 000 years the horizontal displacement of the extrusive zone in the neighborhood of the Trans-Atlantic Geotraverse was 2-4 km. It is postulated that there was a local increase in the thickness of the magnetically active layer as a result of intensive serpentinization processes. Figures 8; references 12: 2 Russian, 10 Western.

UDC 581.526.325:574.34(262.5)

#### **Analysis of Black Sea Phytoplankton by Continuous-Flow Cytofluorimetry Method**

907N0148F Moscow *OKEANOLOGIYA in Russian Vol 30 No 3, May-Jun 90 (manuscript received 15 Mar 89, after revision 10 May 89) pp 515-521*

[Article by O. A. Yunev, N. V. Saldan, Z. Z. Finenko, V. V. Zenin and I. I. Babich, Biology of Southern Seas Institute, Ukrainian Academy of Sciences, Sevastopol]

[Abstract] The first determinations of the size distribution of Black Sea phytoplankton were made during an expedition in April 1988 on the "Akademik Vernadskiy." The instrument used was a copy of a continuous-flow cytofluorimeter developed on the basis of a luminescent microscope. A block diagram of the instrument, with 16 components identified, is used in describing the measurement method. Sea water samples were taken from horizons in the layer 0-20 m and at 50 m. The instrument is an ideal counter for measuring the number of single-cell algae measuring 1-150  $\mu$ m. The presence of a linear dependence between the strength of a fluorescence pulse of chlorophyll "a" and cell volume affords a convenient possibility of using the instrument in studying the size distribution of phytoplankton. When employing this cytofluorimeter it is clear that the use of membrane filters does not yield a true picture. The number of phytoplankton fractions measuring less than 3, 3-5 and more than 5  $\mu$ m for the upper layer 0-20 m averaged 71, 19 and 10%; for the horizon 50 m the corresponding figures were 55, 20 and 25%. The contribution of the size groups by biomass is opposite that obtained with respect to number. In the 20-m layer the fractions less than 3, 3-5 and more than 5  $\mu$ m by biomass were 6, 3 and 91% respectively, and at the 50-m horizon, 2, 1 and 97%. Figures 4; references 12: 5 Russian, 7 Western.

UDC 551.466

#### **Nonlinear Interaction of Beams of Short Two-Dimensional Monochromatic Internal Waves in Exponentially Stratified Fluid**

907N0150A Moscow *DOKLADY AKADEMII NAUK SSSR in Russian Vol 311 No 4, Apr 90 (manuscript received 12 May 89) pp 970-974*

[Article by Yu. D. Chashechkin and V. I. Neklyudov, Mechanical Problems Institute, USSR Academy of Sciences, Moscow]

[Abstract] A study was made of the nonlinear interaction of beams of short internal waves of relatively low amplitude not accompanied by a catastrophic change in the initial distribution of density and the formation of localized regions of small-scale instability. The experiments were carried out in a laboratory basin measuring 50 x 15 x 50 cm. Two-dimensional internal waves were formed by two wave generators with the to-and-fro motion of several circular cylinders with several different amplitudes and frequencies. A shadow photograph of the wave fields generated in the basin by two independently oscillating cylinders is given showing that the presence of a second beam changes the wave pattern both in the neighborhood of intersection of the beams and outside it. There is a spatial delocalization of the nonlinear distortions observed both within and outside the region of beam intersection. The wave pattern characteristic for one generator is restored after deactivation of the other generator. The nature of the signal registered from the intersecting beams is dependent on the relative position of the measurement point, the spatial structure of the beams, the effective width of the beam and the amplitude of generator oscillations. The nonlinear effects observed in different experimental variants are discussed in detail. Figures 3; references 9: 1 Russian, 8 Western.

#### **Reconstruction of Radiation Fluxes on the Ocean Surface from NOAA Satellite Data**

907N0154A Kiev *MORSKOY GIDROFIZICHESKIY ZHURNAL in Russian No 3, May-Jun 90 pp 30-36*

[Article by N. A. Timofeyev, M. V. Ivanchik, A. I. Sevostyanov and Yu. V. Kikhay, Marine Hydrophysical Institute, Ukrainian Academy of Sciences, Sevastopol]

[Abstract] Total solar radiation and radiation balance fluxes under real cloudiness conditions over an ice-free oceanic surface are reconstructed on the basis of measurements in the near IR in the spectral intervals 0.725-1.1  $\mu$ m and the transparency window 10.3-11.3  $\mu$ m by means of the very high resolution radiometer on the NOAA satellite. Satellite data was received and processed at the Soviet-Guinean scientific center in Conakry, in Sevastopol, and aboard the research ship "Akademik Vernadskiy." An atlas of charts of total solar radiation and the radiation balance for large sectors of the Atlantic has been compiled. Sheets are based on 0.5 x 0.5° latitude/

longitude sectors, averaged from 10-days to a month, with error not exceeding 5%. Algorithms are proposed and recommended as a standard basis for the satellite monitoring of all radiation components of the atmosphere-ocean (ice-free) surface system. The use of these algorithms in the international World Program of Climate Investigations and Tropical Ocean Global Atmosphere programs and in the Soviet Razrezy [Cross-Sections] and SPKOR [Soviet Program on Climatology, Cloudiness, and Radiation] programs. SPKOR, scheduled for 1990, will monitor the radiation fields and cloudiness in the Mediterranean, Black and Caspian Seas, and in the eastern sector of the tropical Atlantic. Data reception and processing will again be managed in the Marine Hydrophysical Institute in Sevastopol, in Conakry, and on the "Akademik Vernadskiy." Figures 4; tables 3; references 8.

#### **Observation of Anticyclonic Eddy Formation in the Offshore Sector of the Black Sea**

907N0154B Kiev *MORSKOY GIDROFIZICHESKIY ZHURNAL* in Russian No 3, May-Jun 90 pp 55-59

[Article by N. A. Panteleyev and A. N. Shcherbakov, Marine Hydrophysical Institute, Ukrainian Academy of Sciences, Sevastopol]

[Abstract] During studies of short-period internal waves in the shelf zone of the Black Sea off the Crimean Peninsula in 1986, an anticyclonic eddy with a horizontal extent of about 20 km was observed moving in a northwestern direction at a speed of 10 cm/s. The passage of the eddy was tracked with current velocity meters and by vertical temperature and salinity profiles. Soundings were made with the "Istok" hydrological probe, two hydrological surveys were conducted, and three autonomous buoy stations, equipped with DISK and DKST current and temperature meters, were deployed. Atmospheric conditions were monitored

during the entire experiment. The passage of the eddy was seen to substantially alter the nature of small-scale hydrophysical processes. It is posited that the cause of the observed eddy formation might have been a dynamic shear instability resulting from a horizontal velocity shear. The Black Sea is characterized by three main types of synoptic changeability of hydrological fields: eddy formations of the Main Black Sea Current, topographic eddies, and frictional eddy formations—the last named being characteristic of the offshore zone. Figures 3; references 2.

#### **Parameterization of the Dispersion Ratio of Internal Waves Based on Soundings in the Tropical Atlantic**

907N0154C Kiev *MORSKOY GIDROFIZICHESKIY ZHURNAL* in Russian No 3, May-Jun 90 pp 59-62

[Article by V. M. Burdyugov and S. A. Grodskiy, Marine Hydrophysical Institute, Ukrainian Academy of Sciences, Sevastopol]

[Abstract] Expressions establishing the relationship between the parameters of the dispersion ratio of the lower mode of internal waves with integral characteristics of the seasonal thermocline are determined. Two models of vertical density distribution—the two-layer and three-layer—are examined on the basis of the Vaisala-Brent  $N(z)$  frequency. Data used to derive the expressions were obtained by the research ships "Akademik Vernadskiy" and the "Mikhail Lomonosov" on various deployments to the tropical Atlantic. The parameterization of the dispersion function obtained provides a convenient way of estimating the relationship of time and space parameters of internal waves for stratification conditions with a clearly expressed pycnocline. This vertical structure of waters is so close to being two-layers that, in the final analysis, the dispersion ratio can be obtained by analogy with the two-layer model. Figures 3; references 3.



UDC 551.521.3.551.463.5.535.36

**Transmission of Layer With Aspherical Spatially Oriented Scattering Particles***907N0137A Tomsk OPTIKA ATMOSPHERE in Russian Vol 3 No 4, Apr 90 (manuscript received 30 May 89) pp 349-353*

[Article by Yu. A. Lebedinskiy, Mogilev Section, Physics Institute, Belorussian Academy of Sciences]

[Abstract] The radiation transfer equation was used in developing a method for approximate computation of spatial illumination and radiation fluxes in a semi-infinite scattering medium and in a plane-parallel layer containing scattering particles of an aspherical configuration with a definite spatial orientation (such as rain drops and ice crystals). Since only particles whose size considerably exceeds the wavelength of light in the visible spectral range have a definite orientation, this makes it possible to simplify the problem, since for large particles the scattering phase function has a sharp maximum in the direction of light incidence. In the computations it is possible to use a transport approximation of the transfer equation giving a high accuracy in computations of spatial illumination. A specific model is proposed for computing layer transmission by this method and a general evaluation of the degree of influence of particle orientation is made possible by a very simple model of parameters of an elementary volume characteristic for crystalline clouds, supplemented by an asphericity model. Figure 1; references 11: 10 Russian, 1 Western.

UDC 551.510

**Research on Vertical Distribution of Optical Density of Aerosols Using Helicopter-Borne UV Photometers***907N0137B Tomsk OPTIKA ATMOSPHERE in Russian Vol 3 No 4, Apr 90 (manuscript received 27 Jun 89) pp 420-425*

[Article by A. N. Krasovskiy, L. N. Turyshch, L. Ch. Neverovich, A. M. Lyudchik, S. D. Ashkinadze and A. I. Kot, Scientific Research Institute of Applied Physical Problems imeni A. N. Sevchenko, Belorussian State University imeni V. I. Lenin]

[Abstract] The design of a UV photometer for use on helicopters is described, a method for mathematical processing of the measurements is validated and sample results of experimental research on the vertical distributions of the optical density of tropospheric aerosols obtained during the summers of 1985 and 1987 near Kzyl-Orda are given. The helicopter-borne "Minsk-1" selective UV photometer is intended for measuring the levels of total, direct and scattered solar UV radiation in the lower layers of the atmosphere. The instrument operating principle is based on successive measurement and comparison of fluxes of scattered and total solar

radiation arriving from the hemisphere with the helicopter blades serving as the separating element. The radiation reaches the photoreceiving system through a diffusely scattering fluoroplastic collector. The direct radiation is modulated by the helicopter blades. The results are registered on an automatic recorder or loop oscillograph. The flux of direct radiation is obtained in the form of the difference in the measured values. The spectral range of the instrument is determined by the curve of spectral response of the photomultiplier used and the type of light filters. Two sets of filters were used ensuring a transmission band with a half-width of about 20 nm and transmission maxima at wavelengths 295 and 322 nm respectively. When making the measurements the helicopter rises to an altitude of 3-4 km and then at a constant rate descends in 20-25 minutes to an altitude 300-100 m. Figures 2; references: 5 Russian.

UDC 621.384.326

**Influence of Anisotropy of Scattering Phase Function on Laser Beam Parameters in Turbid Medium***907N0137C Tomsk OPTIKA ATMOSPHERE in Russian Vol 3 No 4, Apr 90 (manuscript received 17 Jul 89) pp 444-446*

[Article by E. V. Pikkil, V. D. Samoylov and M. S. Chukin, State Optical Institute imeni S. I. Vavilov, Leningrad]

[Abstract] An estimate of the energy and spatial-angular parameters of a laser beam in a turbid medium is made on the basis of the small-angle approximation of a scalar variant of the radiation transfer equation. The point of departure is that an isotropic medium with large scattering particles is described by three optical parameters (extinction index, scattering coefficient, scattering phase function). An estimate of the power of the optical signal passing through a layer of a turbid medium essentially involves allowance for the joint influence of spatial diffusion and the energy attenuation of radiation, as well as multiple scattering in the direction of beam propagation. Allowance for anisotropy of the angular distribution of radiation necessitates computation of the mean square of the angle of ray deflection in an elementary scattering event. The results can be used in computing the parameters of laser beams in the real atmosphere and in estimating the field of view of optical receivers. References: 5 Russian.

UDC 551.501.7

**System for Processing Images in Problems With Sounding of Smoke Plumes***907N0137D Tomsk OPTIKA ATMOSPHERE in Russian Vol 3 No 4, Apr 90 (manuscript received 27 Nov 89) pp 447-448*

[Article by V. L. Mironov, V. V. Morskiy and I. A. Sutorikhin, Water and Ecological Problems Institute, Siberian Department, USSR Academy of Sciences, Barnaul]

[Abstract] Experiments were carried out using a television system combined with an image processing system for studying the possibilities of designing an automatic apparatus for use in seeking smoke effluent in the atmosphere. A block diagram of the videoimage processing system is given. The experiments involved processing of videoimages of smoke plumes of industrial enterprises at Barnaul obtained using a color display processor. The experiments were made during the period 10-31 July 1989 during the light time of day with a range of visibility usually 20-30 km. The apparatus was positioned on the eighth story of a building overlooking the industrial part of the city. In the profile of a smoke plume at a distance 1-2 km from the smoke source there were 4-5 characteristic brightness gradations which were represented by corresponding pseudocolors. The smoke plume concentration can be judged indirectly from the positioning of pseudocolors on a screen. This is illustrated in a specific example. The system can be used as a basis for designing lidar stations for use in automatic search for and investigation of smoke effluent. Figures 2; references: 2 Russian.

UDC 551.465.7:551.5

#### **Role of Adjoint Functions in Research on Response of Model of Atmosphere-Ocean Thermal Interaction to Variations in Input Data**

907N0141A Moscow IZVESTIYA AKADEMII NAUK  
SSSR: FIZIKA ATMOSFERY I OKEANA in Russian  
Vol 26 No 5, May 90 (manuscript received 13 Jun 89)  
pp 451-460

[Article by G. I. Marchuk and Yu. N. Skiba, Computer Mathematics Section, USSR Academy of Sciences]

[Abstract] A method based on use of adjoint equations is proposed for studying the response of a model of thermal interaction between the atmosphere and ocean to perturbations of input data. The values of a number of linear functionals of the perturbed solution are examined as indicators of model response. The spatial-temporal structure of solutions of adjoint problems (influence functions) makes possible a deeper comprehension of the process of formation of system response to external perturbations. This is attributable to the fact that the value of the functional characterizing system response is critically dependent on the structure and amplitude of perturbations of heat sources and initial data in the neighborhood of local influence function maxima. An example is presented: influence functions are analyzed for mid-December surface temperature anomalies for the European USSR and the United States. The important role of energy-active zones of the world ocean in the formation of temperature anomalies is demonstrated. The position of the local influence function maxima for any selected time period determines the specific energy-active zones participating in this process. Figures 3; references 14: 10 Russian, 4 Western.

UDC 551.521.3

#### **Light Scattering by Inhomogeneous Aerosol Particles With Spherical Symmetry**

907N0141B Moscow IZVESTIYA AKADEMII NAUK  
SSSR: FIZIKA ATMOSFERY I OKEANA in Russian  
Vol 26 No 5, May 90 (manuscript received 26 Jun 89)  
pp 517-523

[Article by N. G. Volkov and V. Yu. Kovach, Moscow Physical Engineering Institute]

[Abstract] The standard Mie theory is applicable for a homogeneous sphere and therefore is inapplicable for predicting the optical properties of atmospheric aerosol of anthropogenic origin. However, it is shown that the results of Mie theory can be generalized for an arbitrary multilayer particle having spherical symmetry. The field scattered by such a spherically symmetric particle coincides in form with the field of scattering of a homogeneous sphere with the difference that the Mie coefficients of the scattering series  $a_n$  and  $b_n$  are dependent on the law of change of permittivity and magnetic permeability of a particle in the radial coordinate. An algorithm and computer program in FORTRAN were prepared for computing the efficiency of extinction, total scattering and backscattering on a multilayer sphere with an arbitrary number of layers. These parameters were computed for characteristic laws of the refractive index of particles of atmospheric aerosol of anthropogenic origin. The cases of particles with inner and outer slightly and strongly absorbing layers are examined. Figures 2; references 8: 6 Russian, 2 Western.

UDC 551.466.2

#### **Nonlinear Generation of Kelvin Waves**

907N0141C Moscow IZVESTIYA AKADEMII NAUK  
SSSR: FIZIKA ATMOSFERY I OKEANA in Russian  
Vol 26 No 5, May 90 (manuscript received 31 Jan 89,  
after revision 6 May 89) pp 529-533

[Article by V. V. Petrov and Sh. M. Khasanov, Gorkiy State University]

[Abstract] Until now only the linear mechanisms for the generation of Kelvin waves (generation by a point source, pumping under the influence of atmospheric disturbances and generation due to the scattering of Poincare waves on shoreline irregularities) have been considered. This article gives a solution for the problem of linear generation of a Kelvin wave due to its resonance interaction with two stipulated Poincare waves. The steady amplitude of the generated wave is evaluated using a model in which the role of a stabilizing factor is played by the nonlinear dissipation of the energy of motion in the bottom boundary layer caused by friction. The model was investigated in a wavelength range corresponding to the shallow water and f-plane approximation. The efficiency of Kelvin wave generation is dependent not only on its frequency, but also on the angle of

incidence of the pumping wave. The dependence of the Kelvin wave generation coefficient on angle shows that when it is subjected to the influence of high-frequency Poincare waves this dependence has a resonance character and has a maximum at a definite angle of incidence. Figure 1; references 8: 5 Russian, 3 Western.

UDC 551.521.3

### **Allowance for Rayleigh Scattering in Breakdown of Atmospheric Extinction Into Components**

907N0141D Moscow IZVESTIYA AKADEMII NAUK SSSR: FIZIKA ATMOSFERY I OKEANA in Russian Vol 26 No 5, May 90 (manuscript received 22 Aug 88, after revision 13 Nov 89) pp 550-552

[Article by G. A. Terez, Main Geophysical Observatory]

[Abstract] When making computations relating to problems of atmospheric optics and dynamics the errors in determining Rayleigh optical depth are considered to be minimal or negligible. However, an analysis was made of different methods for computing Rayleigh scattering coefficients proposed by different authors which revealed significant discrepancies in the results. An effort was made to resolve these discrepancies. The most important parameters on which the Rayleigh scattering coefficient are dependent are the refractive index of light in air and the coefficient of optical anisotropy of air molecules. One of the ways to obtain a reliable Rayleigh optical depth curve is to make the values of these parameters more precise. A full review of the literature fails to reveal whether anyone has been successful in achieving this goal. Theoretical and experimental data were carefully studied and a new Rayleigh optical depth curve is proposed which in the wavelength range 0.38-0.35  $\mu\text{m}$  is consistent with the theoretical findings. Then the Rozenberg theory was used for extrapolation into the spectral range 0.35 to 0.30  $\mu\text{m}$ . Figure 1; references 17: 3 Russian, 14 Western.

UDC 551.466.326

### **On the Average Frequency and Duration of Wind Wave Overshoots**

907N0143A Moscow METEOROLOGIYA I GIDROLOGIYA in Russian No 5, May 90 (manuscript received 24 May 1989) pp 66-73

[Article by I. P. Trubkin, Candidate of Physical and Mathematical Sciences State Oceanographic Institute]

[Abstract] Much of the information on the overshoots of wind waves is based on theoretical work done by Rise over forty years ago. There are no analytical expressions suitable for practical use.

Expressions are developed for the probability characteristics of the frequency and duration of overshoots. The sign of the derivative of the overshoots is ignored when a random process intersects a given level. This greatly

simplifies the approach. The average frequency of overshoots is proportional to the probability density and to the average amplitude of the overshoot envelope. The average duration of the overshoots is calculated and given in a figure.

The best approximations for the functions of frequency and duration can be obtained by using model distributions of elevations and envelopes obtained by orthogonal expansion of the probability density. These distributions can also account for nonlinear and unstable processes of wind waves.

The theoretical conclusions reached here were confirmed by experimental data obtained from the Pacific Ocean. Figures 3; references 9: 8 Russian 1 Western.

UDC 551.510.534(99)

### **Study of the Spring Anomalous Behavior of Ozone Above the Molodezhnaya Station (Antarctica) Using Rocket and Earth-Based Ozonometers**

907N0143B Moscow METEOROLOGIYA I GIDROLOGIYA in Russian No 5, May 90 (manuscript received 16 Aug 1989) pp 109-110

[Article by I. V. Bugayeva, D. A. Tarasenko, Candidates of Geographical Sciences, Professor G. A. Kokin, V. I. Pavlov, S. P. Perov, A. F. Chizhov, O. V. Shtyrkov, Candidates of Physical and Mathematical Sciences, and V. N. Terletskiy, Central Aerological Observatory]

[Abstract] A double monochromator was used to measure total ozone content. The vertical ozone distribution was measured with chemical luminescent and optical rocket ozonometers.

Total ozone content decreased at 12-25 km until 7 October 1987. The maximum decrease (60%) occurred at 14-17 km. The greatest change in relative numerical ozone density was at 15 km, about 100%. At 30 km this pattern was not observed. There is a general trend for ozone density to increase from winter to summer. Study of the ozone layer above Antarctica was continued in September-November 1988. It was found that the ozone content was higher, and there was no drop at the ozone maximum (15-20 km) as there was in 1987. 1988 was noted for anomalously high temperatures in the ozone maximum layer, while 1987 was noted for anomalously low temperatures (anomalous high temperatures were observed in 1987 at the stratopause, and not below, while in 1988 high temperatures extended to 10 km).

The expansion of the hole in the ozone observed in 1981-1987 was not observed in 1988; however, this may be due to dynamic processes in the southern hemisphere in 1988. Interannual oscillations in the ozone may be associated with atmospheric thermodynamics. Figures 1; table 1; references 3: 2 Russian 1 Western.

UDC 535.416.3

**Minimizing Phase Distortions of Laser Beam Propagating in Convective Flows**

907N0145A Tomsk OPTIKA ATMOSPHERE in Russian  
Vol 3 No 2, Feb 90 (manuscript received 7 Aug 89)  
pp 123-129

[Article by I. A. Chertkova and S. S. Chesnokov, Moscow State University imeni M. V. Lomonosov]

[Abstract] A theoretical analysis was made of the propagation of light beams under conditions of nonstationary self-induced convection. A closed computation self-effect model was constructed which includes the Navier-Stokes equations and an equation for the complex amplitude of the light field. An elastic mirror, deformable by a system of transverse forces and bending moments, was used for control of the input radiation wave front. The quality of this control is evaluated. A very simple algorithm is proposed for dynamic compensation of the nonstationary beam self-effect in convective flows. Simple programmed control of the beam wave front using an elastic mirror with four servodrives effectively compensates nonlinear phase distortions in a horizontal cell without causing substantial aperture effects. In the considered range of parameters it was found that the relative deviations from undistorted values of such beam parameters as displacement of the energy center and energy radius at the cell output usually change sign with activation of control but in absolute value virtually do not exceed the corresponding values without control. Figures 4; references; 17 Russian.

UDC 621.373.826

**Atmospheric Propagation of Wide-Aperture Laser Beams in IR Range**

907N0145B Tomsk OPTIKA ATMOSPHERE in Russian  
Vol 3 No 2, Feb 90 (manuscript received 11 Jul 89)  
pp 136-141

[Article by I. K. Babayev, M. S. Belkin, V. N. Koterov, A. G. Krasnovskiy and N. V. Cheburkin, Astrofizika Scientific Production Association]

[Abstract] A theoretical study was made of the atmospheric propagation of wide-aperture beams of a CO<sub>2</sub> laser (that is, beams for which the diffraction length considerably exceeds the thickness of the active layer of the atmosphere) with allowance for the thermal self-effect phenomenon. Numerical computations were made of the mean energy characteristics of the radiation in the observation plane on the assumption of both partial and complete coherence of the laser radiation. In a wide range of laser radiation parameters there is a satisfactory correspondence between the results of computations made by two different methods. The described model of atmospheric propagation of partially coherent radiation, despite the simplifications used in it, makes it possible to compute the propagation of wide-aperture laser beams

with a divergence of radiation exceeding the diffraction limit by a factor of 2 or more. The mean energy characteristics of beams propagating through the atmosphere can be described using a model of coherent radiation simulating initial divergence by the introduction of sphericity in the phase front of the radiator with a limiting angle in order of magnitude equal to the characteristic angle of divergence of partially coherent radiation. Figures 4; references 14; 13 Russian, 1 Western.

UDC 541.126

**Combustion of Soot Particles During Propagation of Laser Pulses Through Turbid Atmosphere**

907N0145C Tomsk OPTIKA ATMOSPHERE in Russian  
Vol 3 No 2, Feb 90 (manuscript received 5 Sep 89)  
pp 213-215

[Article by Yu. N. Grachev and G. M. Strelkov, Radio Engineering and Electronics Institute, USSR Academy of Sciences, Moscow]

[Abstract] Due to great energy losses into the ambient medium because of thermal conductivity the combustion of an individual soot particle of submicron size subjected to the influence of a laser beam virtually ceases when the particle attains some critical radius dependent on radiation intensity. Situations are possible, however, when in an aerosol of great density the temperature fields of individual particles overlap. This reduces the heat outflow from particles and favors their stronger heating. The combustion of soot particles is examined in such a case of overlapping of their thermal fields. The temporal dependence of the radius and temperature of a particle with an initial radius 0.15  $\mu\text{m}$  and the mean aerosol temperature  $T$  was plotted. With an energy density 100 J/cm<sup>2</sup> and an optical depth greater than 2 there is total combustion of a particle during the effective time of a pulse, in contrast to a case when the heat from a particle escapes into an ambient medium with a constant initial temperature  $T_0$ . The particle temperature does not drop to the initial value but reaches the level attained by the mean temperature of the aerosol. This theoretical representation of the mechanism of combustion of particles in principle explains the considerable clearing of soot aerosol when subjected to the influence of laser pulses. Figures 2; references: 2 Russian.

UDC 621.373

**Diagnosis of Thermal Track of Strong Laser Beam**

907N0145D Tomsk OPTIKA ATMOSPHERE in Russian  
Vol 3 No 2, Feb 90 (manuscript received 5 Sep 89)  
pp 218-221

[Article by S. P. Istomin and M. Yu. Sverdlov, Altay State University, Barnaul]

[Abstract] An experimental study was made of the process of formation of a thermal track as a result of interaction between a focused beam of a CO<sub>2</sub> laser and a

soot aerosol. A shift interferometer was used in registering the dynamics of the refractive index and temperature of the thermal track. The time of development of free convection and the time of stabilization of a stationary state of the process were determined. A block diagram of the interferometer used (15 components identified) is described. The interference patterns of formation and development of the thermal field were successively registered on motion picture film. The interference kinograms of the process which were obtained indicate that in the initial interaction period the thermal field has axial symmetry. This makes it possible to determine the quantitative distribution of the refractive index. Then free convection develops after 20 ms. After 520 ms the process relaxes and despite the removal of particles by convective flows and Brownian motion the interference pattern does not change. Numerical values of the refractive index were computed from an interferogram obtained 10 ms after onset of CO<sub>2</sub> activation. Figures 3; references: 8 Russian.

UDC 551.551.5:551.576

#### **Anisotropy of Wind Speed Pulsations in Cloudy Atmosphere**

907N0147A Moscow METEOROLOGIYA I  
GIDROLOGIYA in Russian No 6, Jun 90 (manuscript  
received 29 Jun 89) pp 37-44

[Article by M. A. Strunin, candidate of physical and mathematical sciences, Central Aerological Observatory]

[Abstract] The results of analysis of the spectral characteristics of wind speed pulsations in the range of scales from 100 m to 1.5 km, obtained during flights of aircraft-laboratories in the cloudy atmosphere, are given. The most probable state of small-scale turbulence, with scales less than 500 m, in the convective zones of clouds is isotropic; with greater scales isotropy is impaired. In clouds of other genera there is an anisotropy of wind speed pulsations at all scales. In Ac, Sc clouds an excess of the vertical component is more probable, whereas in Ns, As and in exocloud space it is the horizontal component which predominates. The modal values of spectral density of pulsations of the vertical and horizontal wind speed components for convective zones in the region of small scales are close to the Kolmogorov spectrum for locally isotropic turbulence. The rate of dissipation of turbulent energy is essentially dependent on the method for its computation. Correct estimates of this parameter require use only of those parts of the spectrum where both the horizontal and vertical components of pulsations satisfy the  $-5/3$  law. Otherwise an additional error arises which may attain 50% or more of the rate of dissipation of turbulent energy. Figures 3; references 6: 5 Russian, 1 Western.

UDC 551.543.3(215-17)

#### **Semiannual Sea-Level Atmospheric Pressure Variations in Northern Hemisphere Extratropical Latitudes**

907N0147B Moscow METEOROLOGIYA I  
GIDROLOGIYA in Russian No 6, Jun 90 (manuscript  
received 20 Jun 89) pp 45-51

[Article by V. Ye. Sedov, candidate of geographical sciences, All-Union Scientific Research Institute for Hydrometeorological Information-World Data Center]

[Abstract] The mean monthly pressure fields for the 30-year period 1956-1985 were examined for determining the distribution of amplitudes and phases and the contribution of the semiannual cycles to variability in the extratropical latitudes of the northern hemisphere in the latitude range 15-90°N in a grid 5° in latitude and 10° in longitude. An analysis of the amplitude fields indicated that the foci of the strongest semiannual variations of surface-level pressure in the northern hemisphere coincide approximately with the climatic zones of high pressure and are caused by annual variation processes of two types: 1) movement of high pressure zones first in one direction and then in the opposite direction (with maxima of the semiannual amplitude during equinoctial periods), 2) displacement of a high pressure region to the very same region first from the direction of the "continental" anticyclone and then from the direction of the "oceanic" maximum in the solstice months. The semiannual variation of the first type is manifested most clearly and intensively in the subtropical latitudes of the western part of the Pacific Ocean. The semiannual variation signal in this region is the most powerful in the northern hemisphere and attains an amplitude 8 gPa with a contribution of 34% to total variability. Variations of the second type have a more complex character and are observed in the Atlantic and in Africa. In the high latitudes the semiannual variations evidently have a mixed character. The strongest semiannual variations can be used as indicators in checking reliability in the integration of numerical models and should be taken into account in long-range weather forecasts. Figures 3; references 11: 9 Russian, 2 Western.

UDC 551.515.23(265.5)

#### **Interaction of Tropical Cyclones in Pacific Ocean**

907N0147C Moscow METEOROLOGIYA I  
GIDROLOGIYA in Russian No 6, Jun 90 (manuscript  
received 13 Jul 89) pp 60-67

[Article by A. E. Pokhil, candidate of physical and mathematical sciences, USSR Hydrometeorological Scientific Research Center]

[Abstract] Data collected during the 44th cruise of the "Akademik Shirshov" were used in investigating cases of interaction of simultaneous tropical cyclones (TC) in the



northwestern Pacific Ocean in 1988. Unusual movements of these TC are examined. The behavior of real TC in the Pacific Ocean is compared and ideal interacting vortices are examined in a numerical model. In contrast to prevailing concepts on weak or total absence of interaction of TC situated at a distance of more than 1000-1500 km from one another, the opposite is true: in the presence of a background flow common for two TC the interaction of cyclones does occur and is significant. The interaction of TC in some situations and with definite relations of the parameters of vortices gives rise to looplike trajectories and unpredictable steep turns and zigzags. The interaction of tropical and extratropical cyclones occurs in conformity to the same laws. The track of a TC in both the ocean and atmosphere frequently exerts a decisive influence on the behavior of subsequent formation. The presence of interaction of several TC is frequently clearly visible from cloud cover images on satellite photographs. Numerical experiments with binary vortices clearly describe and explain some cases of unusual behavior of interacting TC. Figures 4; references 10: 4 Russian, 6 Western.

UDC 551.465.7:551.515.2(265.72)

#### **Reaction of South China Sea to Influence of Tropical Cyclone**

907N0147D Moscow *METEOROLOGIYA I GIDROLOGIYA* in Russian No 6, Jun 90 (manuscript received 21 Jul 89) pp 68-74

[Article by V. D. Pudov, candidate of physical and mathematical sciences, and V. S. Korolev, Tayfun Scientific Production Association]

[Abstract] Experimental data are given on the thermal reaction of the South China Sea under the influence of tropical cyclone Maymie (19-24 September 1988). This TC was preceded by observations from the "Akademik Kurchatov" and immediately followed by observations from the "Priliv." These observations revealed that the reaction of the South China Sea to the influence of even a weak TC is considerably stronger than the reaction of the open ocean to a strong TC. This experimentally established fact requires construction of a model for the purpose of determining the role of boundary conditions in the thermodynamic reaction of the sea to the influence of TC. The maximal cooling of the upper sea layer during such a storm occurs in the zone of influence of the maximal winds, not at the center of the sea. The main contribution to cooling is from upwelling (50-55%), then from turbulent entrainment (36-37%) and only then from turbulent heat and moisture exchange with the atmosphere (9-13%). The spatial scales of positive and negative anomalies in the storm track may attain depths 800-1000 m and take in areas of tens of thousands of square kilometers. This is substantially greater than the scales of resolution of existing numerical models of TC and therefore must be taken into account in parametrization of interaction between the atmosphere and ocean in a tropical cyclone. Figures 2; references 7: 6 Russian, 1 Western.

UDC 528.7:551.466

#### **Features of Spatial-Temporal Structure of High-Frequency Sea Waves Determined From Photographic Survey and Contact Measurements**

907N0149A Moscow *IZVESTIYA VYSSHIKH UCHEBNIKH ZAVEDENIY: GEODEZIYA I AEROFOTOSYEMKA* in Russian No 1, Jan-Feb 90 (manuscript received 23 Dec 88) pp 99-105

[Article by Yu. A. Ilin, docent, candidate of technical sciences, V. A. Malinnikov, docent, candidate of physical and mathematical sciences, V. T. Polyakov, docent, candidate of technical sciences, and I. I. Strizhkin, docent, candidate of technical sciences, Moscow Order of Lenin Institute of Geodetic, Aerial Mapping and Cartographic Engineers]

[Abstract] Experimental measurements of wave parameters were made in the Caspian Sea, Black Sea and Sea of Okhotsk. A photographic survey with aerial cameras at a scale 1:160 was accompanied by contact measurements with a string wave recorder and a similar instrument with a special spectrum analyzer. Data were obtained for the range of wind speeds 1-20 m/s under different wave development conditions. The photographs were visually interpreted and spectral processing was carried out on a computer. The simultaneous availability of data obtained by these two methods provides a wealth of information which when examined together gives new insights on the development of wave processes. A number of such new findings are discussed in detail. For example, until now the idea has prevailed that ripples are isotropic, but it is now clear that the nature of their spatial distribution is dependent on wind speed, its stability in direction, the sector of the main wave in which the ripples are situated and the length of the ripple waves. Data on the isotropicity of waves, even those obtained from a photographic survey, may be questionable if these factors are not taken into account. Figures 2; references: 10 Russian.

UDC 528.2/3

#### **Experimental Research on Statistical Structure of Refractive Index in Atmospheric Near-Water Layer**

907N0149B Moscow *IZVESTIYA VYSSHIKH UCHEBNIKH ZAVEDENIY: GEODEZIYA I AEROFOTOSYEMKA* in Russian No 1, Jan-Feb 90 (manuscript received 9 Mar 89) pp 105-109

[Article by L. P. Dunayenko, docent, candidate of physical and mathematical sciences, V. A. Malinnikov, docent, candidate of physical and mathematical sciences, and N. M. Padalka, senior instructor, Moscow Order of Lenin Institute of Geodetic, Aerial Mapping and Cartographic Engineers]

[Abstract] Research on the spectral structure of the refractive index indicated that in the spectrum there are

disturbances caused by the influence of wave movements on the sea surface. The number of spectral density maxima corresponds to the number of maxima in the wave spectrum. In the low-frequency spectral range, subjected to the disturbing influence of sea waves, the experimental points have a considerable scatter, attributable to the fact that similarity theory for the near-surface layer does not take this dynamic factor into account. In this part of the spectrum the energy flux in the spectrum of wave numbers is evidently determined not only by the dissipation rate, but also by the quantity of energy transferred directly to the waves. In the inertial frequency range, at the frequencies following the wave maximum, where the direct disturbing influence of surface waves exerts no influence, there is a clearly expressed linear segment at a logarithmic scale. In the case of developing waves the spectrum of fluctuations of the refractive index drops off somewhat more slowly than according to the  $-5/3$  law. The estimates indicated that the A. M. Obukhov-A. M. Yaglom theory can be used for describing regularities in the structure of fluctuations of the refractive index of cm-range radio waves over a wave-covered surface. These estimates of the statistical structure of the refractive index in the near-water layer can be used in estimating fluctuations in the parameters of electromagnetic waves and their influence on the accuracy of geodetic measurements. Figures 2; references: 4 Russian.

#### **Experimental Investigation of Regular Refraction of Laser Radiation Along Short Horizontal Paths in the Ground Layer of the Atmosphere**

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Vol 3 No 5, May 90 pp 451-455

[Article by V. P. Lukin and A. E. Melamud, Institute of Optics of the Atmosphere, Siberian Branch, USSR Academy of Sciences, Tomsk]

[Abstract] Several cycles of experimental investigations of the refraction of laser radiation on short horizontal paths in the ground layer of the atmosphere are analyzed for the purpose of determining the feasibility of forecasting refraction on the basis of weather measurements. The effectiveness of algorithms for forecasting the refraction value based on measured meteorological parameters (temperature profiles, wind velocity) was evaluated. Daily cyclical measurements were made of laser beams propagating about 2 m above homogeneous sectors of the ground surface at distances ranging from 100 to 2,000 m. Experiments were conducted in three climatic zones (Volga, Crimea, West Siberia) using a laser emitter having a wavelength of  $0.6328 \mu\text{m}$  and power of 0.5 mWt. Analysis of results shows that the value of regular refraction of laser radiation exhibits a characteristic daily march with maximum amplitude fluctuations of about  $1'$ , and that forecasts can be made with some certainty. It is concluded that regular refraction of laser radiation along short ground paths exhibits characteristic features requiring further detailed study. Figures 2; references 5.

#### **Transmission of Signals from an Isotropic Source of Optical Radiation Through a Cloud Layer**

907N0151B Tomsk OPTIKA ATMOSPHERY in Russian  
Vol 3 No 5, May 90 pp 538-546

[Article by O. I. Aldoshina, V. V. Bacherikov, A. I. Karkhov and V. A. Fabrikov, All-Union Scientific Research Institute of Opticophysical Measurements of USSR State Standard]

[Abstract] An attempt is made to construct a theoretical model of the transmission path of signals from an isotropic optical radiation source to a remote photodetector, and to find within the structure of this model analytical expressions for pulsed responses and the path transfer function. The model is designed for problems dealing with remote soundings of the surface of the Earth through thick cloud layers. For the first time, an analytical solution is obtained for the problem in the approximate model in which the underlying surface is assumed to be a diffusely scattering Lambertian surface, and the cloud layer assumed to be a thin diffusely scattering screen with a Lambertian scattering phase function. An analytical expression is derived relating the optical source height, cloud layer height, the surface albedo, and the zenith angle of observation. A general expression for an arbitrary number of screens is also obtained. The model may be improved by utilizing known solutions of the problem of radiation transfer through an optically thick medium with anisotropic scattering. Figures 5; references 12.

#### **Self-Excitation of a Ring-Shaped Optical Radiation Beam Propagating in a Solid Aerosol**

907N0151C Tomsk OPTIKA ATMOSPHERY in Russian  
Vol 3 No 5, May 90 pp 559-560

[Article by V. K. Pustovalov and I. A. Khorunzhiy, Belorussian Polytechnic Institute, "Politekhnik" Scientific-Technical Association, Minsk]

[Abstract] The self-excitation of a ring-shaped optical beam propagating in a solid metal aerosol is investigated on the basis of computer solution of a system of equations. The numerical modeling of the beam propagation in this work replicates the conditions in the experiment by N. N. Belov, et al. in "Nonlinear Scattering and Self-Focusing of Laser Radiation in an Aerosol," published in *Quantovaya elektronika*, Vol 12 No 8 pp 1741-1743, 1985. The numerical modeling of the current authors confirms the possible redistribution of intensity in a ring beam propagating in a metal aerosol, established earlier experimentally by Belov, et al., who also demonstrated that the onset of self-focusing is related to the destruction of particles under the effect of radiation. On the basis of these calculations, it is concluded that the first cause of self-focusing resides in the formation of the responsible refraction field. The destruction of the particles occurs in beam sectors where, as the result of self-focusing, radiation intensity notably exceeds  $I_0$ . Numerical results also show that particle temperature can quickly reach  $T_0 = (3-5) \times 10^5 \text{ K}$ , thus leading to particle destruction. Figures 2; references 8.

**On the Ecological Situation in Western Kazakhstan and Problems of Environmental Protection When Natural Resources are Being Intensively Developed**

907N0132A Alma Ata VESTNIK AKADEMII NAUK  
KAZAKHSKOY SSR in Russian No 3, Mar 90 pp 32-37

[Article by Ye. V. Gvozdev, member, KazSSR Academy of Sciences, and A. P. Korotkov, chairman, KazSSR State Committee for the Protection of Nature]

[Text] Rich in natural resources and with diverse geomorphological, landscape and climatic features, western Kazakhstan includes the North-Caspian lowlands, the Preurals and Transurals Plateau, Mugodzhary, the Northern Aral region and the desert plateaus of Ustyurt and Mangyshlak. Its administrative units are Ural, Aktyubinsk and Gurev oblasts. There are steppes with chernozem soils in the northern part of the region and broad expanses of desert and semidesert in the south. The Ural River, with its tributaries (Sakmara, Ilek, Utva, Chagan, Kushum), is the region's largest river and has an important influence upon its natural environment.

Among the natural resources of countrywide, and even worldwide, importance are its huge reserves of oil, gas, chromite, rare metals, the fisheries of the Caspian and the Ural River, commercial marine animals (seals) and land animals (saiga). Also important are the plant resources of the Ural River floodplain and of the steppe and desert with a diversity of forage grasses that at one time made it possible to feed up to 3 million head of livestock on the Ustyurt Plateau. However, this natural wealth is also the reason for the damage inflicted upon nature in recent times. The incredible human caused load upon ecosystems in this sparse ecosystem is leading to the catastrophic loss of rangeland and, in river floodplains, of forests. There is a steady loss of topsoil from much agricultural land (especially around industrial areas), and soil fertility is declining everywhere. As a result, crop and animal productivity is declining and the fisheries, previously a prestige sector, are losing their importance.

In recent decades we have, for some reason, started to forget that everyone is based upon and lives on the land and its soil cover. It is not gas, oil or chemicals, but the soil and the plant and animal world, the embodiment of life on earth, that are the basis for all. Humanity's fate depends upon the well-being of these components of the environment, and not upon technogenic potential.

In the epoch of scientific and technological progress the interaction of humanity and nature has become one of the most urgent problems. Scientific and technological progress develops productive forces, improves people's lives and assures the further techno-economic development of society. However, increasing human interference causes changes in the environment that can lead, and in places do lead, to irreversible ecological (and biological) consequences. The ecological catastrophe around the Aral Sea is an example of this. We will not be

able to greatly improve the situation there if we do not stop the steady drop in the level of the Aral Sea. It is difficult to imagine and responsibly predict what will take place in this vast region if this unique lake disappears.

One result of the negative impact of humans upon nature is steady and, unfortunately, not declining, pollution by toxic chemicals, industrial wastes and dust, which causes acid rain. There is also the salinization of soils, the dumping of industrial and construction wastes and the exhaustion of topsoil. It is also unfortunate that people make use of only 1 percent of the total volume of material extracted from the earth.

Water use by industry and agriculture has reached levels such that polluted waters cannot clean themselves after being discharged into natural bodies of water. This applies to some areas of western Kazakhstan.

What is the ecological situation in the region at the present time?

The natural wealth of Kazakhstan's part of the region around the Caspian Sea, which makes up one-fourth of the republic, is based on formation of a multisectoral economic complex focused on oil and gas extraction and the processing of hydrocarbon feedstocks. The largest oil reserves being prepared for development are concentrated in Gurev Oblast (82.7 percent) and gas and condensate in Ural Oblast (58.3 and 92.5 percent). With the introduction of the Tengiz and Zhanazhol oil fields and the Karachaganak gas condensate field, oil extraction in the region will reach 29.7 million tons, condensate extraction—8.3 million tons and gas extraction—17.1 billion cubic meters. By the year 2000 the scheme for the development of productive forces in the region calls for increasing oil extraction to 55 million tons and gas extraction to 50 billion cubic meters.

The creation of a large capacity oil and gas complex in the Caspian region will have a definitive effect upon the development of related sectors, above all thermal power engineering and the construction industry. This means that there will be a several fold increase in the production of construction materials. It will be necessary to introduce large heat and electric power plants. Of course, all this cannot help but have an effect upon the ecological situation in the region. This is all the more true because this development is occurring even though there are many unsolved water supply problems and very limited water resources that do not even meet the present requirements of industry, urban development and agriculture.

The average annual surface water resources in the region (the Ural River, small rivers and intermittent streams) is estimated at 13.6 cubic kilometers, 38.5 percent of which originates within the region. This means that water runoff in the future will decline because of water use in the upper reaches of rivers located outside the region. The total demand for fresh water just for the normal

functioning of industry, including the oil and gas condensate complex, is 650-750 million cubic meters annually. The plan for water supply in western Kazakhstan, developed by Soyuzgiprovodkhoz calls for the construction of the 1,100 km long Volga-Mangyshlak Aqueduct, with a capacity of 90 million cubic meters annually. It is to be completed before 1995. Plans call for the remaining demand for water (around 540-650 million cubic meters annually) to be met by the Volga-Ural Canal, the introduction of which is foreseen by 1997. However, the ecological aspects of this solution have still not been elaborated as there are no forecast indicators of the condition of Volga River ecosystems, especially the delta region. As previously, the industrial development of a huge territory and the construction of industrial complexes has begun, but no detailed ecological study of the situation has been made, nor have environmental conditions been included in the plans at the necessary levels. As a result, even now, during the first period of development, there is a real threat to ecosystems not only in the Caspian Sea, but in the region as a whole.

The natural environment of the Caspian region is experiencing considerable anthropogenic loads. In 1989 air pollution levels in oblast centers reached the following levels: Aktyubinsk, 2.6 times the maximum permissible concentration for dust; in Gurev 4.4 times the maximum permissible concentration for dust and 3.2 times the maximum permissible concentration for oxides of carbon; in Uralsk—2.6 times the maximum permissible concentration for dust and 1.9 times for maximum permissible concentration for oxides of nitrogen. In the settlement of Kulsary in the Tengiz oil field the concentration of hydrogen sulfide is 5-7 times the maximum permissible concentration. In settlements near the field the concentration of hydrogen sulfide in the air is over 14 times the maximum permissible concentration, while that of sulfur 2.9 times higher. The concentration of hydrogen sulfide in the air along the shores of the Caspian exceeds the maximum permissible concentration by a factor of 7.3. All this requires rapid intervention by Goskompriroda, the Ministry of Health and other republic organs.

River pollution is cause for great concern. In the middle stretches of the Ural River in 1988 the highest concentration of sulfates was 1.2 times the maximum permissible concentration, and that of petroleum products, 2.5 times, while in the lower stretches these figures were 2 and 8 times the maximum permissible concentrations respectively. Considerable concentrations of DDT, hexachlorates and other pesticides have been discovered here. The failure to observe water protection laws will lead to catastrophic pollution of the Ilek River and the groundwater in its valley by chrome and boron salts. The concentration of these substances in groundwater sources is now 500 times the maximum permissible concentration.

Anthropogenic factors are now creating a very stressful water resources situation in the Ural River Basin. In recent years the multiyear average annual runoff of the

Ural has been reduced from 10 to 4 and in some years to 2 cubic kilometers. The optimal runoff for fishery needs must be not less than 8 cubic kilometers annually.

The decline in the runoff of the Ural River has led to a shrinkage of the hydrological system. More than 600 hectares of natural spawning grounds for semi-migratory fish have been destroyed. There has also been a decline in the reproducing stock of sturgeon. Poor water circulation in the lower reaches of the river reduces oxygen content and increases the concentration of toxic substances in the water, leading to a massive loss of fish. All this reduces the fish productivity of the river, which is the world's only body of water where sturgeon reproduce naturally.

In order to protect the sturgeon spawning grounds, during 1980-1987 the Kazakh SSR Council of Ministers passed a series of decrees limiting the volume of river freight transport and the dredging of sand and gravel from the river bottom, which are very damaging to sturgeon reproduction. Fish stocks are greatly affected by design imperfections in the water intake structures of the Ural-Kushumskaya irrigation and water supply system, the Inderskaya irrigation system and others, the majority of which do not have special fish protection devices. This alone causes the region's fishery to annually lose many millions of fish, depriving its citizens of tens of thousands of tons of fish products. The sturgeon catch in the Ural-Caspian Basin declined from 10,000 tons in 1980 to 3,100 tons in 1988. In the 13th Five-Year Plan calls for a sturgeon catch of around 1,800 tons annually. If this trend continues we will soon lose sturgeon altogether and cease to be an exporter of this product. The situation is made more difficult because in recent years toxic chemicals have caused a disease in fish—myopathy. Its symptoms are a breakdown of muscles and degeneration of roe while it is in female fish. In 1987, 90 percent of the sturgeon in the Volga were affected by myopathy; by the spring of 1988, 100 percent were. The unique population of sturgeon is on the verge of extinction. If the pollution of the Ural River with toxic chemicals is not halted, then the inevitable will happen to the sturgeon in this river. The culprits in this tragedy will be the industrial enterprises that discharge industrial wastes into the river basin prior to any preliminary treatment.

In order to improve the situation and to prevent the loss of aquatic ecosystems, Uralkasprybvod [Ural-Caspian Fisheries and Water Resources Administration] has developed a program for protecting the environment and rationally using nature in the Ural-Caspian region. It calls for halting the construction of dams and reservoirs on large and small tributaries of the Ural River, a reexamination of the boundaries of the reserve zone and the eastern delta of the Volga, the improvement of sturgeon spawning grounds in the Ural River, the installation of effective fish protection equipment on intake structures, the construction of protective levies to prevent high waters from polluting the sea, the completion of the sturgeon hatchery in Gurev and several other measures. Saving this unique fishery from extinction



requires rapidly halting the pollution of the Ural River and its tributaries and implementing all measures necessary to return it to full water levels, assuring that runoff is not less than 8 cubic kilometers annually.

Research conducted by Kazakh SSR Academy of Sciences institutes during 1988-1989 shows that the unfavorable ecological situation in the area around the Caspian Sea continues to worsen due to the negative consequences of oil and gas field development. Gas condensate and oil extraction operations continue to be accompanied by gross violations of existing laws on environmental protection and industrial safety.

The deteriorating ecological situation in Novobogatin-skiy and Embinskiy rayons and in the Tengiz field is manifested by intensified human caused pollution of biota, the air, soil and ground by oil and gas products, especially near drilling operations. There are disturbances of the natural process when protective dikes are built. The soil is dried out and wind erosion occurs because of the reduced river runoff.

In many places, especially within oil fields, there are disturbances in the normal (natural) functioning of fragile desert and semidesert ecosystems. Desertification affects more than 1 million hectares here. The topsoil has been completely destroyed on over 100,000 hectares around oil field operations.

Massive losses of waterfowl are observed around oil field operations on shores of the Caspian Sea. Hundreds of thousands of birds have been killed. More than 80,000 birds died in the Tengiz area alone in 1988. Most of the birds perish in the oil fields. According to estimates that are far from complete, at least a million birds have died from pollution of water areas and land by petroleum products and related toxic substances. Considerable losses, especially among predatory birds, are also caused by high voltage power line towers, even though there are recommendations to prevent this.

Other animals also suffer in regions of intensive development around the Caspian Sea. Valuable hoofed animals die from falling into open trenches for oil and gas pipelines. The wire fences around so-called cultivated pastures along the Ural River are impassable barriers to migrating saiga. Totally unjustifiable human pressure is threatening valuable desert animals, including species entered into the Red Book of the Kazakh SSSR. In the Ustyurt area large numbers of muflon and Middle Asian gazelles die not only at the hands of poachers, but also from sharp reductions and deterioration of their habitat.

The unique and small Ustyurt Preserve, set up with great difficulty, is suffering from the onslaught of technology. Exploratory drilling for oil is still under way here, the area is being polluted, the natural migratory pathways of animals are being disturbed, the already meager vegetation is being destroyed and wide areas are being turned into desert. Given this situation, it will be difficult to count upon support for the creation, in the next few years, of two other preserves and several zoological and

botanical protected areas as recommended by the KazSSR Academy of Sciences and included in the general scheme for the development of natural reserves in the Kazakh SSR.

All this is evidence that ecosystems in western Kazakhstan are already in a condition close to ecological crisis. Consequently, the development of this region requires a completely different approach, one based upon a thorough study and analysis of this situation and upon forecasts of the future condition of ecosystems in the Caspian region.

A detailed techno-economic analysis of all technological and environmental protection decisions regarding the exploitation of oil and gas fields is also made necessary by the complex geological bedding conditions of oil and gas bearing strata, the high content of hydrogen sulfide coming from gas wells (up to 3.8 percent) and from oil wells (up to 33.3 percent), the high concentration of liquid hydrocarbons in gas bearing strata and the catastrophic ecological situation in the region. So far not a single preplanning and predesign document has been approved: neither the scheme for regional planning, the scheme for the development of oil, gas and related sectors, nor others. The lack of an ecologically based program for developing the territory also affects the quality of planning and estimation documentation for construction work at the Tengiz oil field and the Karachaganak gas condensate field and for environmental protection measures; in particular, a comprehensive scheme for environmental protection at oil and gas fields in western Kazakhstan. The plan for constructing the Tengiz oil field has not answered questions about the comprehensive use of the products extracted, about the need to reconstruct existing and to construct new facilities for processing Tengiz oil; there has been no analysis of the corrosion resistance of the existing pipeline in which it is intended to transport oil to Kuybyshev or of the suitability of equipment or the readiness of personnel at the Kyubyshev oil refinery, who have not worked with such toxic raw materials. There have been no solutions to questions of processing byproducts. According to underestimated calculations, flares will burn up to 60,000 tons of ethane, 30,000 tons of propane and 60,000 tons of light hydrocarbons. This will mean not only losses of valuable chemical feedstocks but also considerable air pollution and negative environmental consequences.

These reasons and several other shortcomings led the Kazakh SSR Goskompriroda to refuse approval of the Tengiz oil field construction work plan for environmental protection and the rational use of natural resources.

The planning-estimation documentation for the Karachaganak gas condensate field was approved on the condition that it contain special provisions for reducing the anthropogenic environmental load upon the region, including measures to prevent accidents and to reduce



total emissions of harmful substances into the atmosphere, additional measures for corrosion monitoring of equipment and pipelines, and for the development and rapid introduction of gas protection and other measures.

We should always keep in mind that the laws of nature are objective and do not depend upon our wishes. While in the past, when human influences upon nature were not very strong, nature itself eliminated the negative consequences of this impact, today, during the scientific-technical revolution the power of human interference in nature often exceeds the power of natural processes. Consequently, in order to avoid undesirable consequences it is necessary to constantly give consideration to the laws of nature and not neglect them in our daily activities.

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### Temperature and Ozone Trends in Tropical Stratosphere

907N0147E Moscow *METEOROLOGIYA I  
GIDROLOGIYA* in Russian No 6, Jun 90 (manuscript  
received 16 Aug 89) pp 115-116

[Article by S. P. Perov and S. Kh. Rozenfeld, candidates  
of physical and mathematical sciences, Central Aerological  
Observatory]

[Abstract] The temperature variation and vertical ozone distribution (VOD) were analyzed in the tropical region where their seasonal variability should be minimal and where the reliable detection of trends caused by anthropogenic influences is possible. Temperature data over Tumba station (8°N, 77°E) were analyzed using series of observations with Soviet M-100 meteorological rockets (1970-1987, a total of 714 launchings). Two series of observations were analyzed using a specially developed statistical analysis method, within whose framework the expansion coefficients of a number of observations are evaluated using a base system of functions. The behavior of the  $H_3$  parameter (scale height of VOD) was investigated for reducing the possible influence of systematic errors on the result. An analysis of the seasonal-latitudinal variability of  $H_3$  indicated that in the middle latitudes at altitudes 36-50 km the  $H_3$  value has a minimal variability during the summer months (15-20%). In the tropical zone ( $\pm 10^\circ$  from the equator) the  $H_3$  variations are somewhat greater. An interesting feature of this zone is a negative  $H_3$  trend in the layer 38-47 km beginning in 1979. Such rocket data can be used in checking data in an analysis of the longest series of observations of the vertical distribution of ozone by the inversion method. Figure 1; references 3: 2 Russian, 1 Western.

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